X-ray imaging and electron temperature evolution in laser-driven magnetic reconnection experiments at the NIF

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We present results from X-ray imaging of high-aspect-ratio magnetic reconnection experiments driven at the National Ignition Facility. Two parallel, self-magnetized, elongated laser-driven plumes are produced by tiling 40 laser beams. A magnetic reconnection layer is formed by the collision of the plumes. A gated X-ray framing pinhole camera with micro-channel plate (MCP) detector produces multiple images through various filters of the formation and evolution of both the plumes and current sheet. As the diagnostics integrates plasma self-emission along the line of sight, 2-dimensional electron temperature maps $\langle T_e \rangle_Y$ are constructed by taking the ratio of intensity of these images obtained with different filters. The plumes have a characteristic temperature $\langle T_e \rangle_Y = 180 \pm 30$ eV, 2 ns after the initial laser irradiation and exhibit a slow cooling up to 4 ns. The reconnection layer forms at 3 ns with a temperature $\langle T_e \rangle_Y = 280 \pm 50$ eV as the result of the collision of the plumes. The error bars of the plumes and current sheet temperatures separate at 4 ns, showing the heating of the current sheet from colder inflows. Using a semi-analytical model, we find that the observed heating of the current sheet is produced by electron-ion drag, rather than the conversion of magnetic to kinetic energy, in these experiments.